ALUMINUM

Project Fact Sheet

Effect of Impurities on Alloys

Benefits

- Potential cost savings of $42.7 million by 2020
- Potential energy savings of 6.2 trillion Btu by 2020
- Full implementation of this technology by 2020 would displace 147,000 tons per year of CO_2

Applications

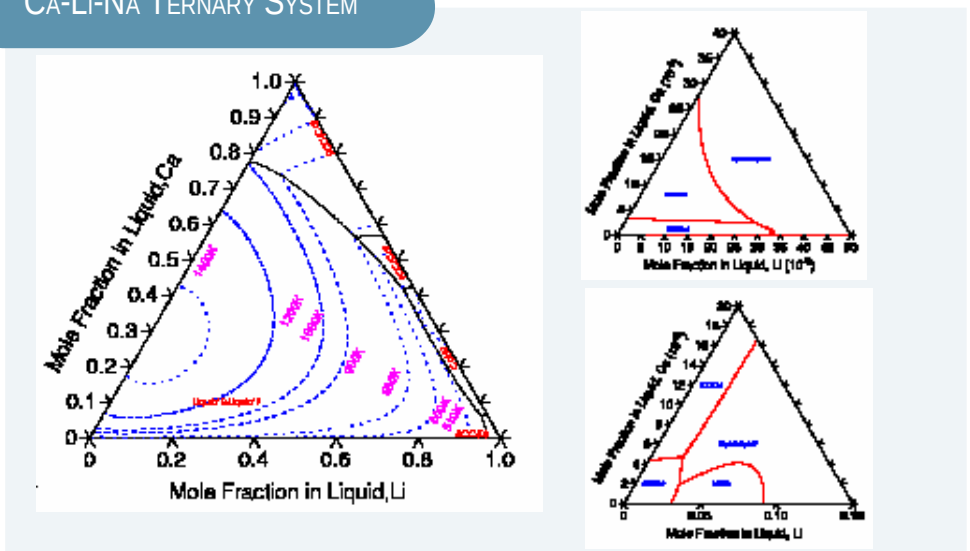
During melting and casting, impurities increase melt loss of aluminum alloys used in the automotive industry. This research will investigate the effect of impurities on aluminum alloy processing.

Effect of Impurities on the Processing of Aluminum Alloys

Calcium, lithium, and sodium are elements that are regarded as impurities in many aluminum alloys. The impurities contribute to the rejection rate of aluminum sheet and bar products. Rejected products must be remelted and recast. During this process, a portion of the aluminum is lost to oxidation (melt loss). Removal of calcium, lithium, and sodium increase overall melt loss of aluminum alloys. They increase the hydrogen solubility in the melt and promote the formation of porosity in aluminum castings. Although these elements have been identified as detrimental impurities for the extrusion aluminum alloys, no systematic research has been carried out to investigate the behavior of these impurities during aluminum alloy processing.

Project partners are investigating the effect of impurities on aluminum alloy processing with the aim of lower product rejection rates with the resultant effect of lower melt losses. The goal of this project is to quantify the effect of impurities on the processing of multi-component aluminum alloys used in casting, extrusion, and rolling processes. Specific activities include; (1) developing a thermodynamic database on aluminum alloys containing Al, Na, Ca, Mg, and Li; (2) conducting computational thermodynamic simulations to determine the phase equilibria of multi-component alloys containing the impurity elements; (3) conducting kinetic simulations to determine the segregation behavior of the impurity elements and their influence on the phase evolution during processing conditions; and (4) verifying results of simulations by conducting experiments under industrial processing conditions.

Ca-Li-Na Ternary System



Liquidus projection of the Ca-Li-Na Ternary System.

Project Description

Goals: The goal of this research is to develop a thermodynamic database for impurities of calcium (Ca), lithium (Li), and sodium (Na) in multi-component aluminum alloys; validate predicting capability; and quantify the impurity effect on the processing characteristics of aluminum alloys by casting, extrusion, and rolling processes.

Progress and Milestones

The goals will be met by completing the following tasks:

- Development of thermodynamic databases of binary systems and model interface segregations in binaries.
- Development of thermodynamic databases of ternary systems and model interface segregations in ternaries.
- Integration of binary and ternary impurity data with the commercial aluminum databases.
- Prediction and experimental validation of the effects of impurities on interface segregation in multi-component commercial alloys during the casting process.
- Prediction and experimental validation of the effects of impurities on phase transformation during processing and heat treatment of commercial alloys.

Commercialization Plan

This technology will be made available to the industry through journal publications and/or technical presentations. The final thermodynamic database will be tested with the commercial aluminum thermodynamic database and can thus be used jointly with the commercial thermodynamic database for the processing design of aluminum alloys. The thermodynamic database can be marketed separately for fundamental research and development activities or jointly with the commercial aluminum database.

Project Partners

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